the details of the didactic course. It is probably true that, under proper conditions of environment, a parrot could be taught a hymn, for we have proof of his power in acquiring a secular vocabulary. In the same way, undoubtedly, a student can be taught a certain kind of anatomy by lecture, diagrams and models. But I question whether he will find this knowledge much more useful than the parrot his hymn. Assimilation of anatomical knowledge requires demonstration of the actual structures, to a limited number of students, for the purpose of enabling each to see and examine the objects themselves with which he is to become familiar, not models or diagrams. "I asked for bread and they gave me a stone" —or a model—is a saying which no student of anatomy should have occasion to apply to his own case.

This reason has led to the replacement of the didactic lecture by the section demonstration. I still concede to the lecture, modified and supplemented by demonstration, an important function in furnishing the orderly, logical and systematic presentation of the subject which is to serve as the guiding thread in the student's individual examination of the structures. It is the proper place for the elaboration of the broad morphological principles of vertebrate structure, but these should be illustrated and emphasized by the direct examination of the structures involved. The lecture should indicate clearly the main facts of which the student is to satisfy himself by personal observation in the demonstration. Both conducted side by side are mutual supplements.

Such, in brief, I conceive to be the main factors in the advance of anatomical teaching. Many secondary aids, such as the complete pedagogic separation of elementary and advanced students, the modern methods of preservation of material, the improved technique of preparations, the introduction of elective and optional courses in general morphology and others would demand consideration if more time were at our disposal.

But, however brief and insufficient my presentation of the subject may appear, teachers of anatomical science feel that the advance along the lines indicated is a material gain and that, under the broad spirit of our universities, it will be progressive.

GEO. S. HUNTINGTON.

## PHYSIOLOGY IN MEDICAL SCHOOLS.

THE paper which I have had the honor of preparing for this occasion consists of three parts; the first gives a critical review of the present unsatisfactory methods of teaching physiology in medical schools (in which institutions most of the physiological teaching is done); the second presents a detailed proposal for instruction in accordance with what are believed to be correct pedagogical principles; and the third discusses ways and means, and demonstrates that the proposed changes are within the present means of any successful school. The time allotted to each speaker requires the omission of the critical account of present methods and the discussion of ways and means. Only the second part of the paper can be given here.*

The picture I have drawn of the instruction in physiology in medical schools will not be challenged by teachers of that science. The sense that our methods of instruction neither develop nor much inform the mind is general. It is time that discussion of the difficulties and the way to remedy them should also be general. Physiology is the most highly developed rational discipline in medicine—not a merely descriptive science like anatomy and is well adapted to train the mind in scientific procedure, in the setting of problems for research, in the

*The full paper is printed in the *Boston Medical and Surgical Journal*, December 29, 1898.

criticism of methods and results, and in the tests which lay bare shallowness—matters of great moment to men who shall practice an applied experimental science in the midst of quackery, illusion and pretence. Careful inquiry should therefore be made to determine how far defects of instruction can be remedied with the means at our disposal. The problem is: How far can the correct theory be realized in practice? To what extent can medical students of physiology be taught in the manner in which men are trained to be professional physiologists? Evidently physiologists are likely to study their own subject in the most profitable and labor-saving way.

Much can be done to reconcile theory to practice, but not everything. The size of physiology has broken it into specialties. Even professional physiologists can no longer have personal acquaintance with the whole subject or even a relatively large part of it. The truth of this will be obvious when it is remembered that since January 1, 1894, more than three hundred researches have been published on the physiology of the heart alone. To a considerable degree the physiologist himself must acquire his information from reading the work of others. It would therefore be idle to expect the student of medicine to get a personal experimental knowledge of the whole subject. He has but a year for physiology and must share that time with anatomy. Grave economic laws demand this time shall not be lengthened, and the day of self-support postponed. The time which he now has must be used chiefly for training and not chiefly for the acquisition of facts, as at present, and this training must follow the lines laid down by physiologists for their own development.

The way of the physiologist is not peculiar. The method of getting a real education is the same from the kindergarten to the specialist. The principle is to train 'for power,' to use President Eliot's phrase, and not primarily for information. Deal so far as possible with the phenomena themselves and not with descriptions of them. Use as the basis of professional instruction the facts and methods which shall be used by the student in earning his living. Teach the elements by practical work. Associate facts which the student can observe for himself with the facts which he cannot observe. Control the progress of the student, remove his difficulties, and stimulate him to collateral reading by personal intercourse in the laboratory, by occasional glimpses of the researches in progress in the laboratory, and by daily conferences or seminaries. Give the student careful descriptions of the method of performing his experiments, but require him to set down the results for himself in a laboratory notebook, which, together with the graphic records of his experiment, is to form a requirement for the Doctorate. Choose one sufficiently limited field in which experimental work shall be thorough and comprehensive, affording a strong grasp of that special subject. Add to this the typical, fundamental experiments in other fields.

When the student has come thus far, let him choose one of several electives affording advanced training in the physiology of the medical specialities, such as opthalmology, laryngology, the digestive tract, the nervous system, etc. These courses should be thorough, should contain the physiology required of the best specialists, and above all should deal with nature directly. For example, in studying the physiology of the stomach, the gastric juice should be taken with the stomach-tube directly from the human object, and not obtained merely by adding hydrochloric acid to scrapings of the mucous membrane of swine. This special instruction should be directed by distinguished specialists. Thus the student will be brought into contact with that which will

interest him most, the every-day methods of the best physicians, and the specialist will keep his own foundations in repair. It is in connection with these courses that didactic lectures should be given. Up to this point in his work the student is not ripe. Let there be one to four lectures of not more than forty-five minutes, the subject very limited, so that each set shall present all the existing knowledge on the subject. The purpose of these lectures is to show the student the historical development of scientific problems, the nature of scientific evidence, and the canons of criticism that shall help him to sift the wheat from the chaff of controversy. Lectures of this kind cannot profitably be given by men who have not made experimental investigations in the subject of the lecture; so far as practicable they should be given by the specialists who advise the physiological staff concerning the special courses.

Each student should be required to present one written discussion of some very small and sufficiently isolated thesis, giving the work of the original investigators, together with any observations the student has made for himself. The way of dealing with the sources at first hand will thus be learned.

The student's reading should be correlated strictly with his practical work and should be done in the laboratory in connection with that work. It should not be memorizing, as at present, but the study of graphic records, physiological-anatomical preparations and other physiological material, with the aid of the text-book. The corrections necessary to bring the book up to date and to correlate it with the practical work can be furnished in printed or mimeographed notes.

Such are the lines along which sound theory directs that the teaching of physiology in medical schools should proceed. With such a training the student can safely find his way through the constantly augmenting horde of facts and draw vicarious profit from those who are face to face with the mysteries of nature. Such instruction meets also the needs of men intending to make a profession of biological sciences other than medicine. It will be observed that the course offers: (1) thorough experimental acquaintance with one field, say the physiology of nerve and muscle, giving the point of view, the general physiological method, training in technique, a basis of analogy, adequate knowledge of one living tissue and thus the elements of all; (2) the fundamental elementary experiments in the remaining fields; with the key which the first course gives, these will unlock much; (3) thorough experimental acquaintance with one special subject; (4) various complementary gains, of which may be mentioned experience in reaching the original sources and in marshalling facts, a certain degree of skill in the methods used by practitioners, direct correlation between physiology and practical medicine. Much might be said of the value of this group, particularly of the correlation just mentioned, but we must hasten on to the demonstration of how these ends are to be attained practically.

The first problem to be solved in planning instruction is whether the student's time is to be given wholly or only in part to the subject taught. Men in training for professional physiology commonly concentrate their energies for a sufficient period on this one subject, and this is regarded as the most economical way of mastering any science, for the ground gained by one day's work is still fresh in the mind when the next day's work begins, and continuity of thought is not disturbed. The plea that the instruction in one subject should be broken by the injection of other subjects in order that the instruction in each may have 'time to sink in' need not be entertained;

experience shows that much of it sinks in so far that it cannot be got up again without the loss of valuable energy. A more serious objection is that the method of continuous application is highly fruitful in the case of men of exceptional powers, who are keen in spite of protracted effort, but is wasteful for the average brain, which is fatigued and unreceptive after some hours of unremitting labor. The truth of this must be allowed, but the objection does not apply to wide-ranging sciences, such as anatomy and physiology, which are not narrow, hedged-in areas, but which consist rather of broad and diversified domains composed of many contiguous fields, the varied nature of which is a perpetual refreshment. In practice the student of anatomy may divide his time between general anatomy, descriptive human anatomy, histology and embryology, all of which are now taught in the medical curriculum, and the student of physiology may pass from general and special physiology to physiological chemistry, thus resting the mind without interrupting the continuity of effort essential to instruction that must be both rich and frugal.

I would propose, then, that the first year in medical schools be divided equally between anatomy and physiology, the first four months being given to general anatomy, descriptive human anatomy, histology and embryology; the second four to physiology and physiological chemistry, studies which cannot be pursued without a knowledge of anatomy.

In accordance with the principles already outlined, the instruction in physiology should be divided into three parts. Part I, of five weeks' duration, should consist of a thorough drill in the physiology of nerve and muscle, the hours from 9 to 11 being devoted to experiments, the hour from 11 to 12 to study of materia physiologica (physiological preparations, graphic records, etc.), and the time from 12 to 12:45 to a conference or seminary, which should be part lecture, part recitation. In the conference the bearing of the experimental work just done should be developed by systematic progressive questioning accompanied by running comments, to clear up any possible fog. A brief account of other experiments which add to the truth established by those which the student has done for himself, but which are too complex or too protracted to lie within the student's powers, should be brought in here.

Part II, of seven weeks' duration, should comprise carefully-arranged fundamental experiments giving in turn the elements of each field in physiology except that of nerve and muscle, which has just been studied. As before, the whole class works from 9 to 11 upon experiments, from 11 to 12 studies all possible means of illustrating the subject of the day, and from 12 to 12:45 attends the conference or seminary. In the forty-two days covering this part of the course instructors who find the mixture of lecture and Socratic method unsympathetic may abandon their questioning and fill the time with their own remarks; even such instruction would be far more fruitful than the present lectures, for the student would have had experience in anatomy and would be well grounded in experimental physiology, through his work on nerve and muscle, before the talk began; but the seminary is much more effective than the lecture.

In Part III, covering the remaining four weeks of the term, the instruction is divided into special courses on the physiology of the eye, ear, larynx, digestion, the spinal cord, the innervation of the heart, etc. Each course should consist of experimental work from 9 to 11, the study of preparations and other aids from 11 to 12, and a conference from 12 to 12:45. Each course should be long enough to include all the practicable experiments that should find a

place in a systematic, thorough study of the subject. The number of such experiments, and hence the length of the special courses, will naturally be very different in the various instances; thus experimental physiology of the eye will occupy more time than the physiology of the larynx. As many courses should be given at one time as there are instructors in the department. The student may elect the subjects that most interest him, but must choose a sufficient number to occupy him during the entire four weeks of instruction.

The afternoons of the days on which physiology is taught are devoted to physiological chemistry.

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## PSYCHOLOGY.

THE invitation to talk about the methods of teaching psychology was to me in one way very welcome. All the year long I have done nothing with fuller conviction than to tell the psychologists that they ought not to meddle with methods of teaching, as they can hardly offer any aid. But there is one exception, and here I have at last a welcome chance to make the necessary appendix to my year's sermon; the psychologists ought not to trouble themselves with the methods of teaching which the other men apply, but they ought, in the highest degree, look out for the methods which they use themselves, as there is perhaps no science in which bad methods are so confusing and dangerous.

But the invitation came also as an embarrassment. The methods of psychology, on account of the many changes in recent years, have so far not had the time to crystallize; they have not reached the stage of an objective form about which the psychologists themselves agree, and it is a hopeless task to seek there anything which is more than a reflex of personal experiences. I felt this difficulty strongly and cannot offer, therefore, anything but an expression of my subjective convictions, which can claim in their favor nothing but the fact that they are based on observations in a university where the rather uncritical rush towards psychology has reached unexpected proportions.

The time is too short to demonstrate here, what even every outsider ought to know, that a scientific psychology is to-day in first line experimental psychology and that collections of instruments are thus the necessary, full laboratories the desirable background of teaching psychology. The audience, on the other hand, is here too various to allow a description of special important pieces of apparatus. I want, therefore, to emphasize merely questions of principle.

Such a question of principle it is to ask which place this experimental psychology ought to have in the lecture courses of the university. To say the experimental work ought to be the whole is absurd; that is possible for physics or physiology, but it is impossible for psychology. The physical sciences start with fundamental conceptions and presuppositions which are acknowledged without difficulty, while in psychology just the basal conceptions like consciousness, psychical causality, psychical elements, psychophysical parallelism are full of difficulties and certainly not open to experimental treatment. The usual way now is that the elementary treatment of mental life deals with this general theoretical book-psychology, while the more advanced lecture courses go forward to an exact experimental study of the special facts.

This seems to me a methodological blunder; the order ought to be just the opposite. I think, firstly, that the treatment of the theoretical questions in psychology is of no value whatever if it is given in an elementary way; every problem leads here to epistemological discussions which go far